

NASA Technical Memorandum 86857

**Publications of the NASA Space
Biology Program for 1980-1984**

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Publications of the NASA Space Biology Program for 1980–1984

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PREFACE

The Space Biology Program, within the Office of Space Science and Applications of the National Aeronautics and Space Administration, was established to use the unique characteristics of the space environment to advance knowledge in the biological sciences (see Introduction for a detailed description of the Space Biology Program).

The intent in compiling this bibliography is twofold, first, to provide the scientific community with a listing of publications resulting from research pursued under the auspices of NASA's Space Biology Program, and secondly, to stimulate the exchange of information and ideas among scientists working in the different areas of the program. To facilitate this exchange process, we have identified Space Biology Program research principal investigators by asterisks. A listing of principal investigators and their affiliations can be found starting on page 97.

References are arranged by year under the headings "Plant Gravitational Research," "Animal Gravitational Research," and "General." Keyword title indexes appear on pages 85-93. This bibliography listing only includes references identified and entered into the Life Sciences Bibliography Data Base (housed at The George Washington University) as of August 15, 1984.

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INTRODUCTION

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THE NASA SPACE BIOLOGY PROGRAM

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Introduction

One of the major features of the physical environment on the surface of Earth is the constant presence of the force of gravity. Terrestrial gravity has important biological consequences for organisms living on Earth. The phenomenon of weightlessness which is encountered on spacecraft provides an excellent biological research opportunity, both because of its uniqueness to space and because of the importance of gravity to life on Earth. Access to space provides an opportunity to manipulate gravity from its norm of one down to almost zero, effectively providing the full spectrum of gravitational research capability for the first time. This capability, combined with the stability and pervasiveness of gravity on Earth, its obvious impact on biological evolution, and its continuing effect on the morphology, physiology, and behavior of living organisms, has led the Space Biology Program to concentrate its efforts and resources on investigating the biological significance of gravity.

Program Goals

The goals of the Space Biology Program are to: use the unique characteristics of the space environment, particularly microgravity, as a tool to advance knowledge in the biological sciences; understand how gravity has shaped and affected life on Earth; and understand how the space environment affects both plant and animal species, thereby enhancing our capability to use and explore space.

Program Scope

Research in the Space Biology Program is divided into three broad areas:

1. Gravity perception. The objectives are to identify gravity receptors in organisms sensitive to gravity and determine their structure and function, and to elucidate the mechanisms by which gravitational stimuli are perceived and transmitted to a responsive site.
2. Developmental biology. The objectives are to determine the effects of gravity, and especially weightlessness, as provided by spaceflight, on the genetic integrity,

cellular differentiation, reproduction, development, growth, maturation, and senescence of living systems; and to examine the evolutionary importance of gravity as a determinant of the form and function of terrestrial life.

3. Biological adaptation. This area includes the use of gravity's physiological effects to explore biological problems; and achievement of an understanding of how gravity affects and controls the physiology, morphology, and behavior of organisms, of how gravity and other environmental stimuli and stresses interact in this control, and of the biological mechanism by which living systems respond and adapt to altered gravity, particularly that of the space environment.

Research Opportunities

With the proven feasibility of the Space Shuttle, we now have a new capability of performing biological experiments in space. The opportunity has arrived to use the locker space within the Shuttle orbiter on a continuing space available basis. This will provide a valuable augmentation to the ongoing ground-based research program.

Spaceflight will provide the validation for many experimental hypotheses developed in ground-based research, while gravitational experiments on Earth will continue to hone the questions, provide the necessary baseline data, and develop spaceflight experimental protocol.

The experimental approach of the ground-based studies in the Space Biology Program is to manipulate gravity on Earth and develop weightless simulation models to: (1) develop and test gravitational hypotheses, (2) identify gravity-sensitive biological systems and interacting environmental response mechanisms, (3) analyze biological systems and mechanisms known to be gravity-sensitive, (4) analyze flight experiment data and iteratively expand ground research capability, and (5) plan and design future space experiments. In addition, research is conducted to understand how the uncontrollable biodynamic factors of the spacecraft will affect the results of the various flight experiments.

Focus of Program

The research focus of the Space Biology program is dependent upon several dynamic factors: the requirements of NASA, the characteristics of flight experiment opportunities, the sensitivity of specific biological systems to gravity, the scientific value of the research, the state of knowledge and technology in the specific scientific areas, the interest of scientists in studying the biological questions, and the

availability of funds to support the research.

Within the scope of the Space Biology Program, the current Program is focused on answering the following basic scientific questions:

1. What are the components of the gravity-sensing mechanisms of plants and animals? How do they perceive information? How is the information transmitted to evoke responses?
2. Does gravity influence fertilization and development of plants and animals, and can fertilization and development proceed normally in a near zero gravity environment? If gravity does affect fertilization and development, what are the sensitive physiological systems and how are they affected? If early development is affected by gravity, is it a result of an effect on the parent or a direct effect on the embryo itself?
3. What is the role of gravity in the formation of structural elements such as lignin, cellulose, silica, chitin, and bone calcium phosphates at the molecular level as well as at more complex organizational levels?
4. What role does gravity play in calcium-mediated physiological mechanisms and in calcium metabolism?
5. How does gravity as an environmental factor interact with other environmental factors to control the physiology, morphology, and behavior of organisms? Or, how do gravitational and other environmental stimuli interact in the control and direction of living forms? Can the action of gravity be replaced by different stimuli?

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PLANT GRAVITATIONAL RESEARCH

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PLANT GRAVITATIONAL RESEARCH

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